

Anticipated Climate Change Impacts in South Florida Parks

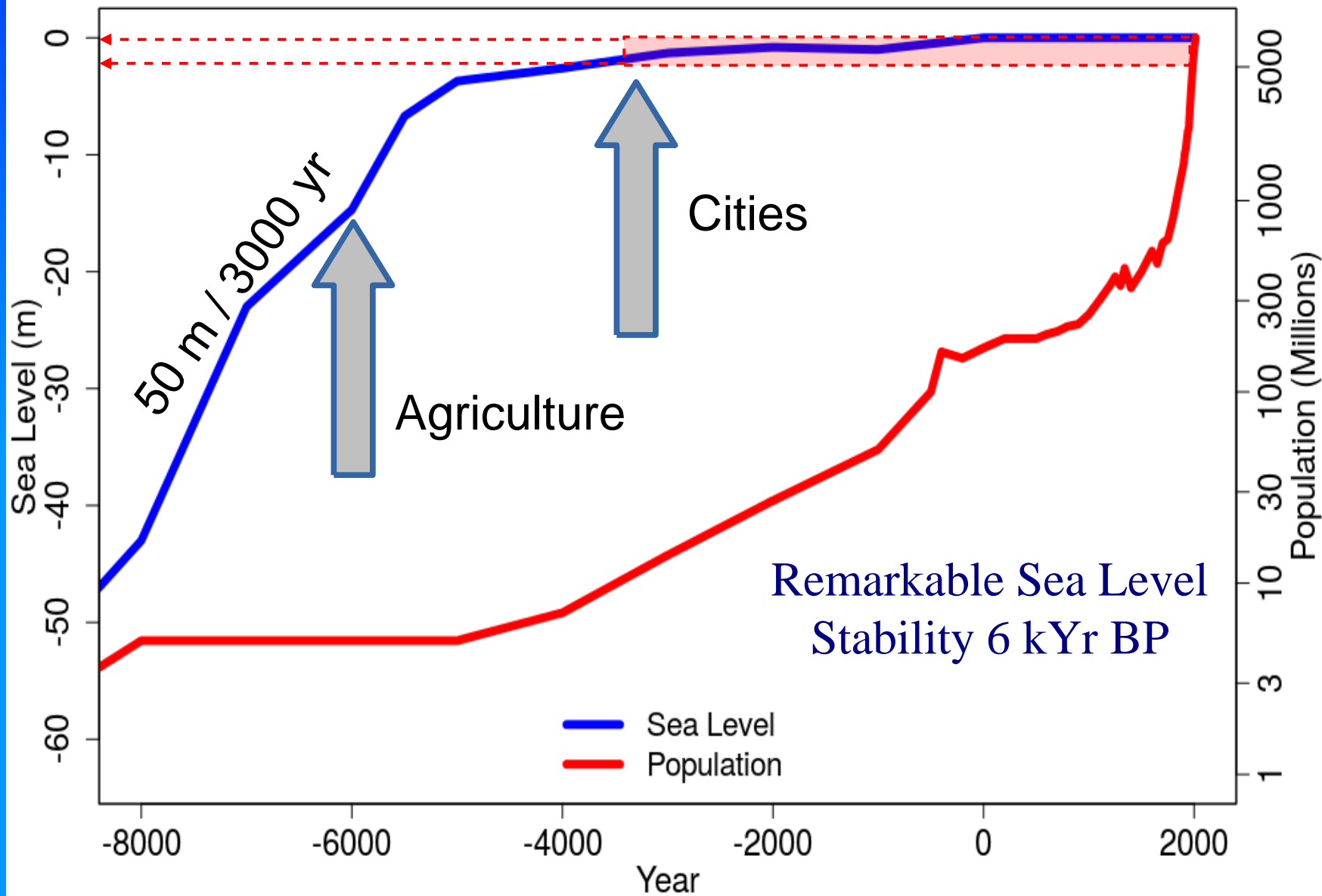
Erik Stabenau
Joseph Park
Jed Redwine
Kevin Kotun

January 18 2017

South Florida Natural
Resources Center







Complete Global Ice Melt



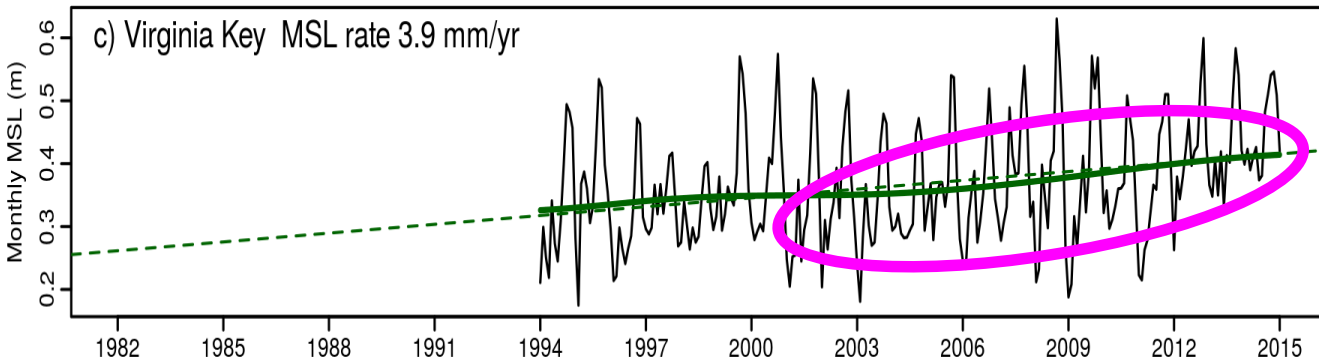
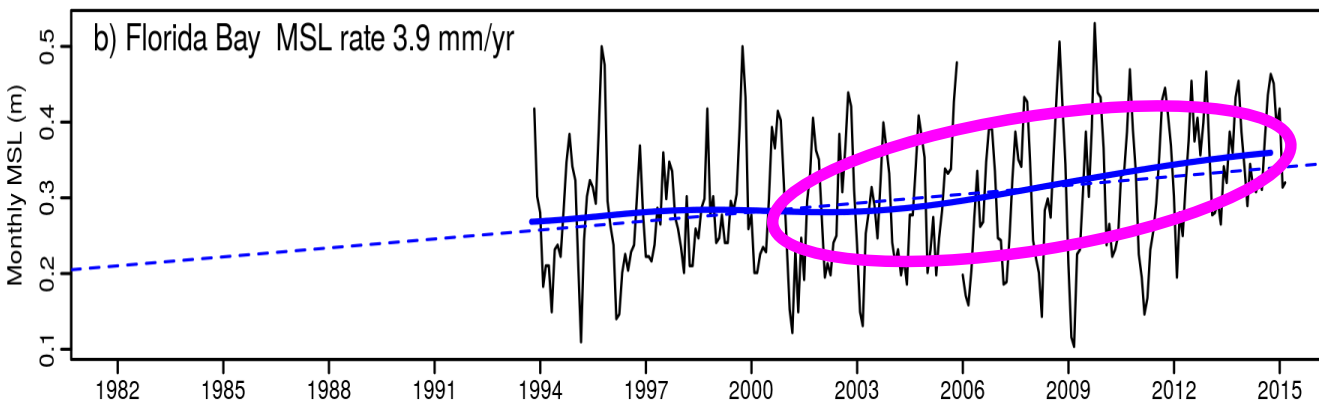
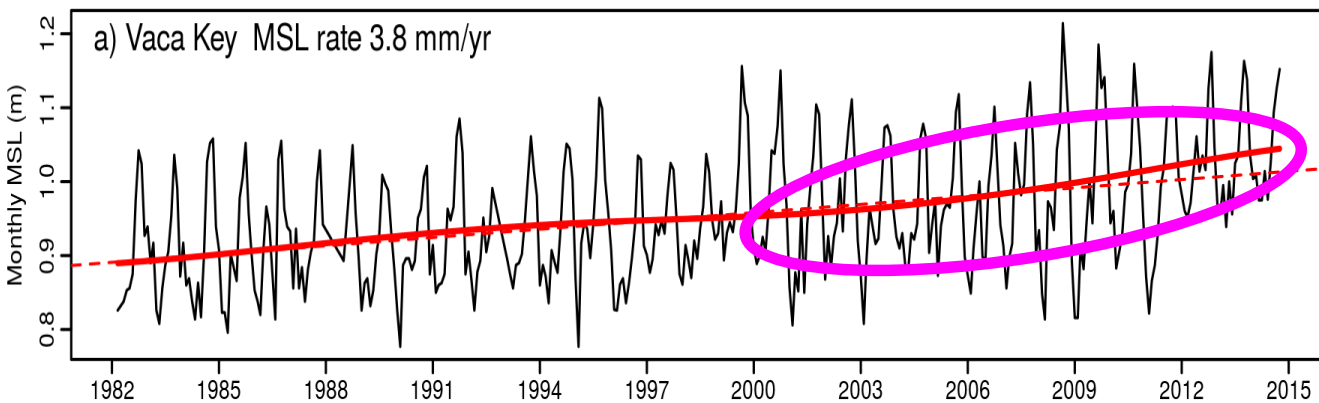
Linear Rates

$$60 \text{ m} / 4 \text{ mm/yr} = 15,000 \text{ yr}$$

$$60 \text{ m} / 20 \text{ mm/yr} = 3,000 \text{ yr}$$

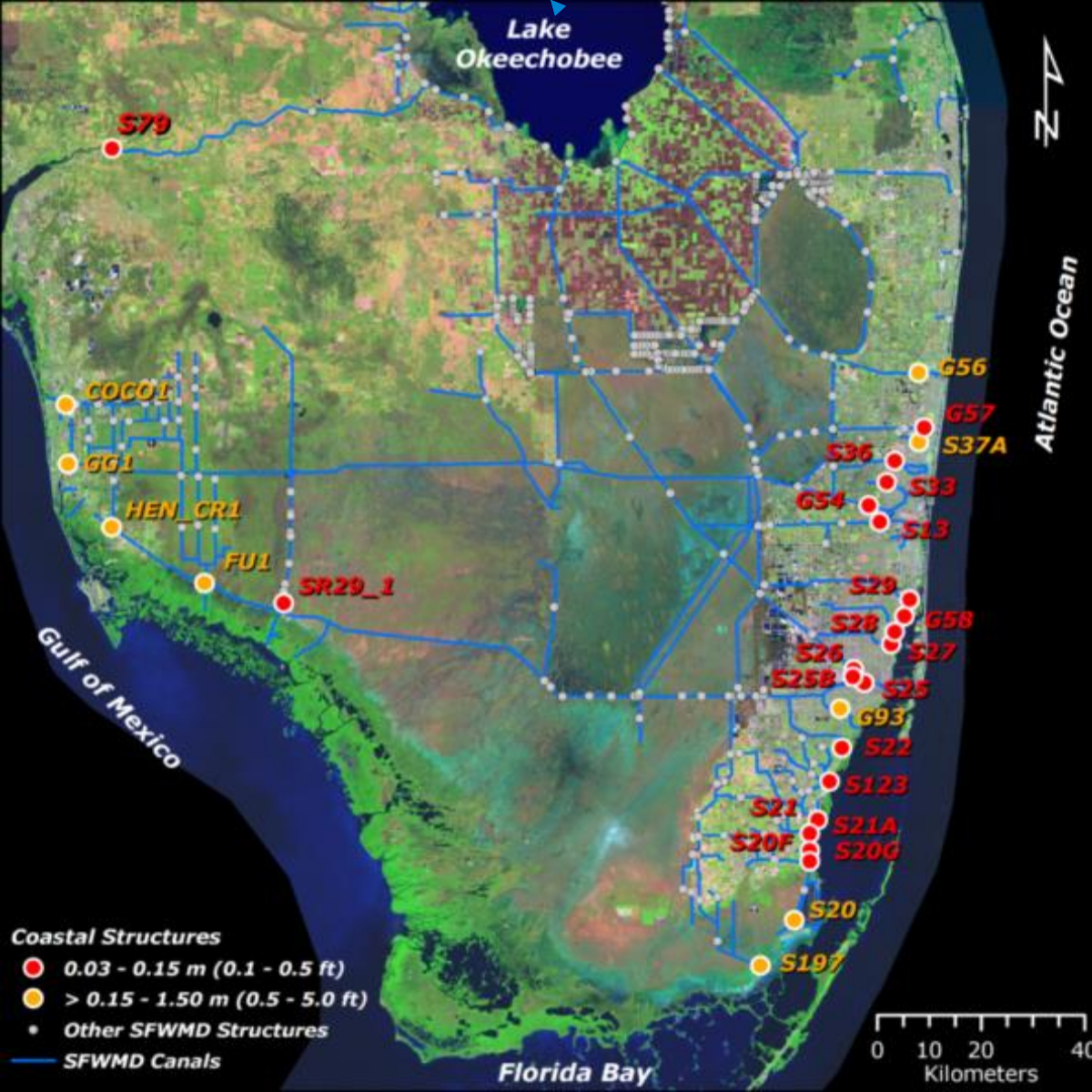
Non-linear Rates

Currently unpredictable



Mean Sea Level around South Florida has been rising at twice the long-term linear rate over the last decade.



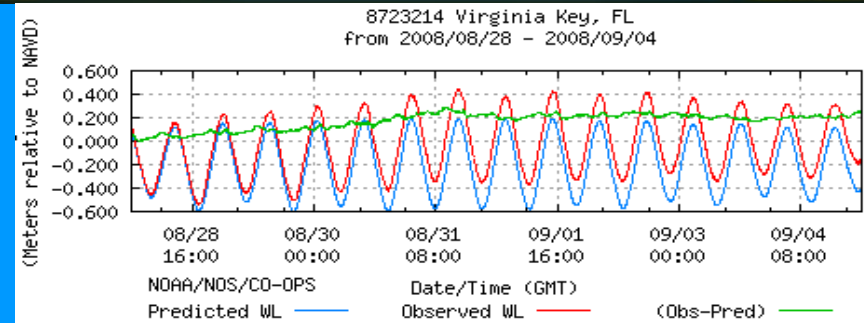
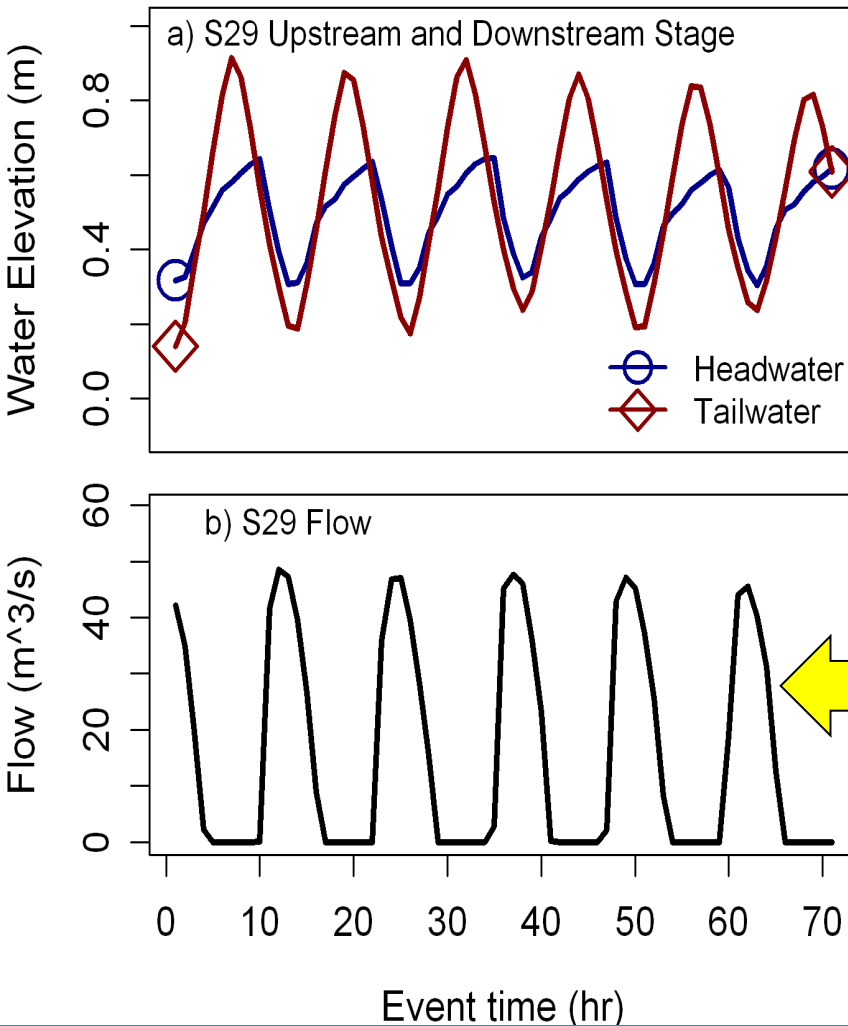


Topographic Gradients

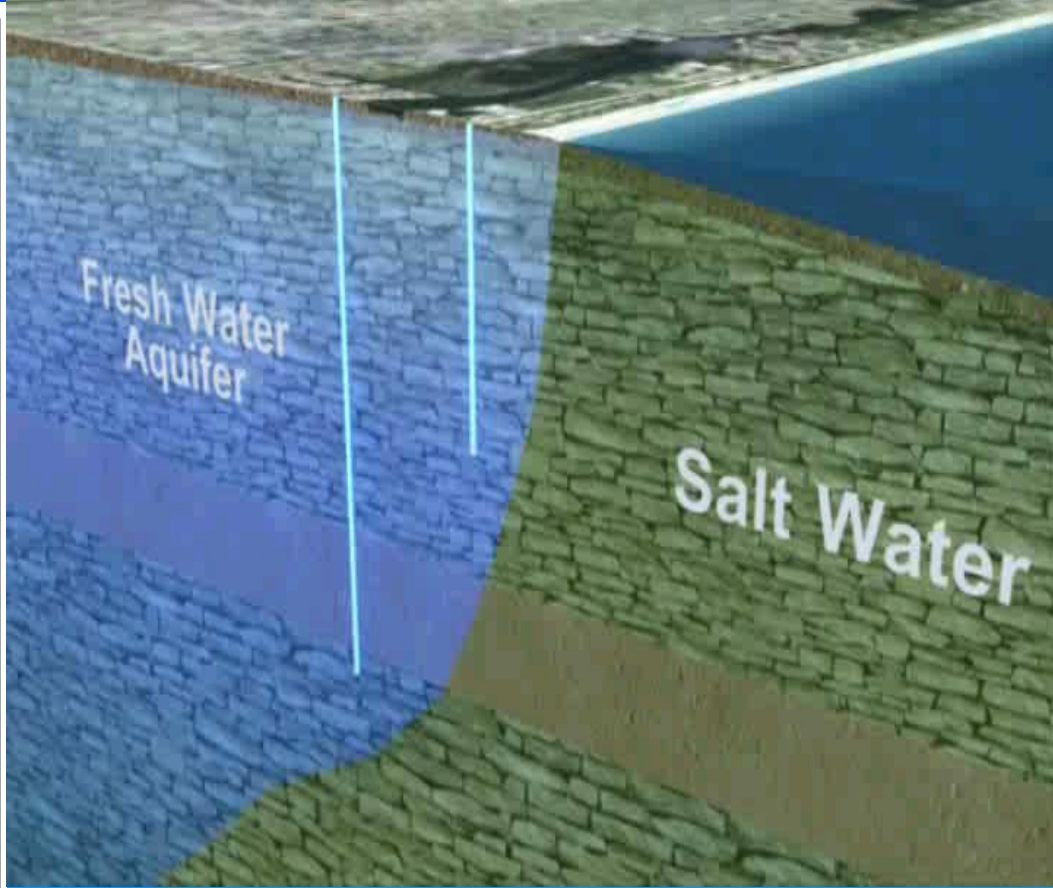
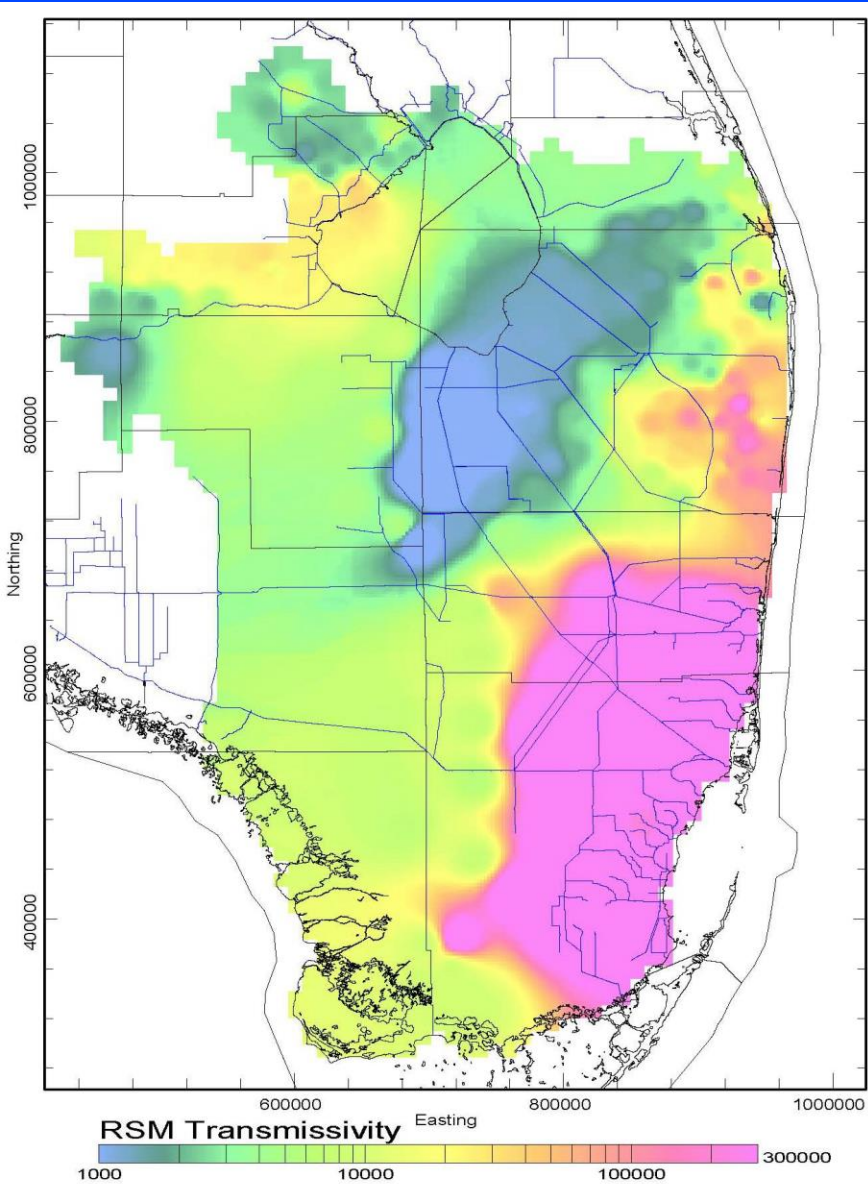
1 : 16000
1 : 6000

Coastal weirs with a design elevation differential circa 1950 of 0.15 m (6 inches) in red.

S-29 Discharge Event



September 1, 2008 10:00



Hydrologically, the ocean and aquifer are a continuum.

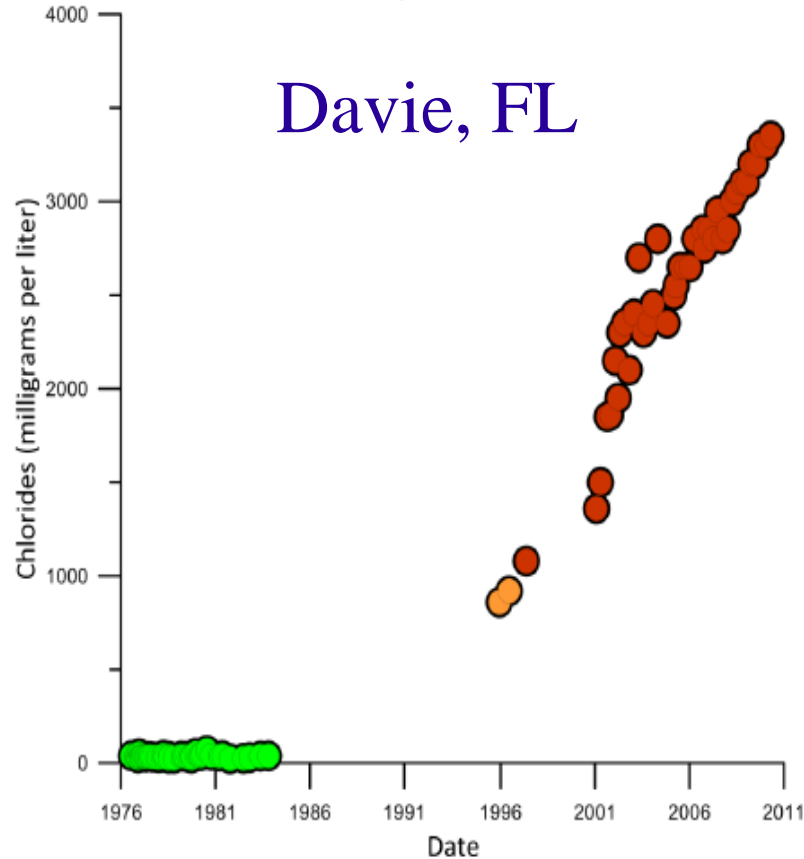
Water Supply Well Chloride Monitors

G-2264

Casing Depth: 195'

Total Depth: 203'

Davie, FL

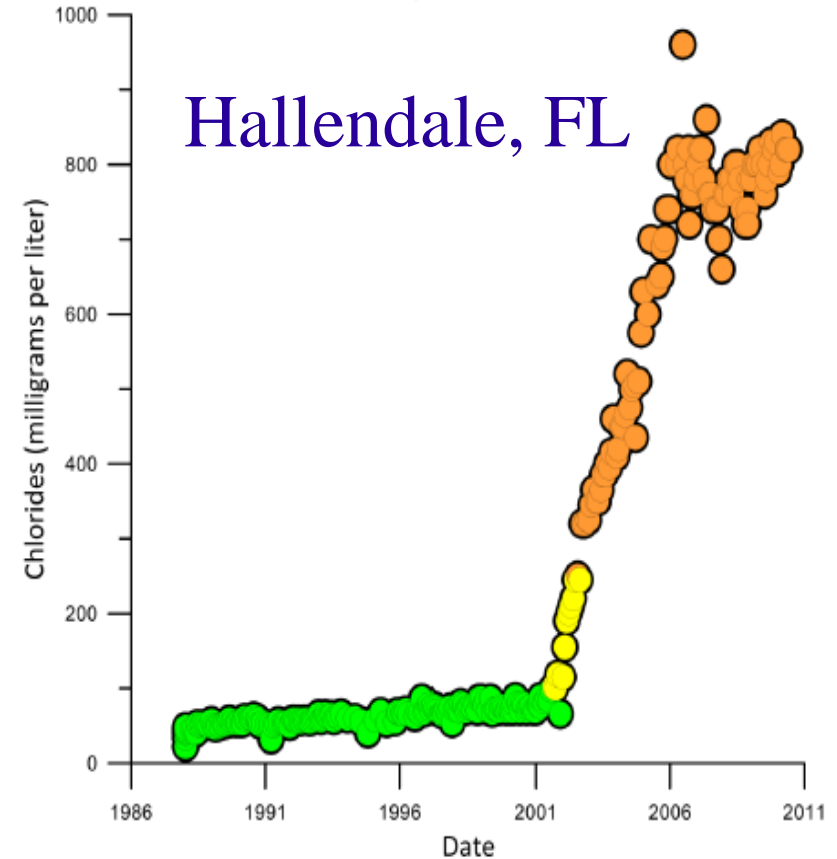


G-2478

Casing Depth: 197'

Total Depth: 202'

Hallendale, FL



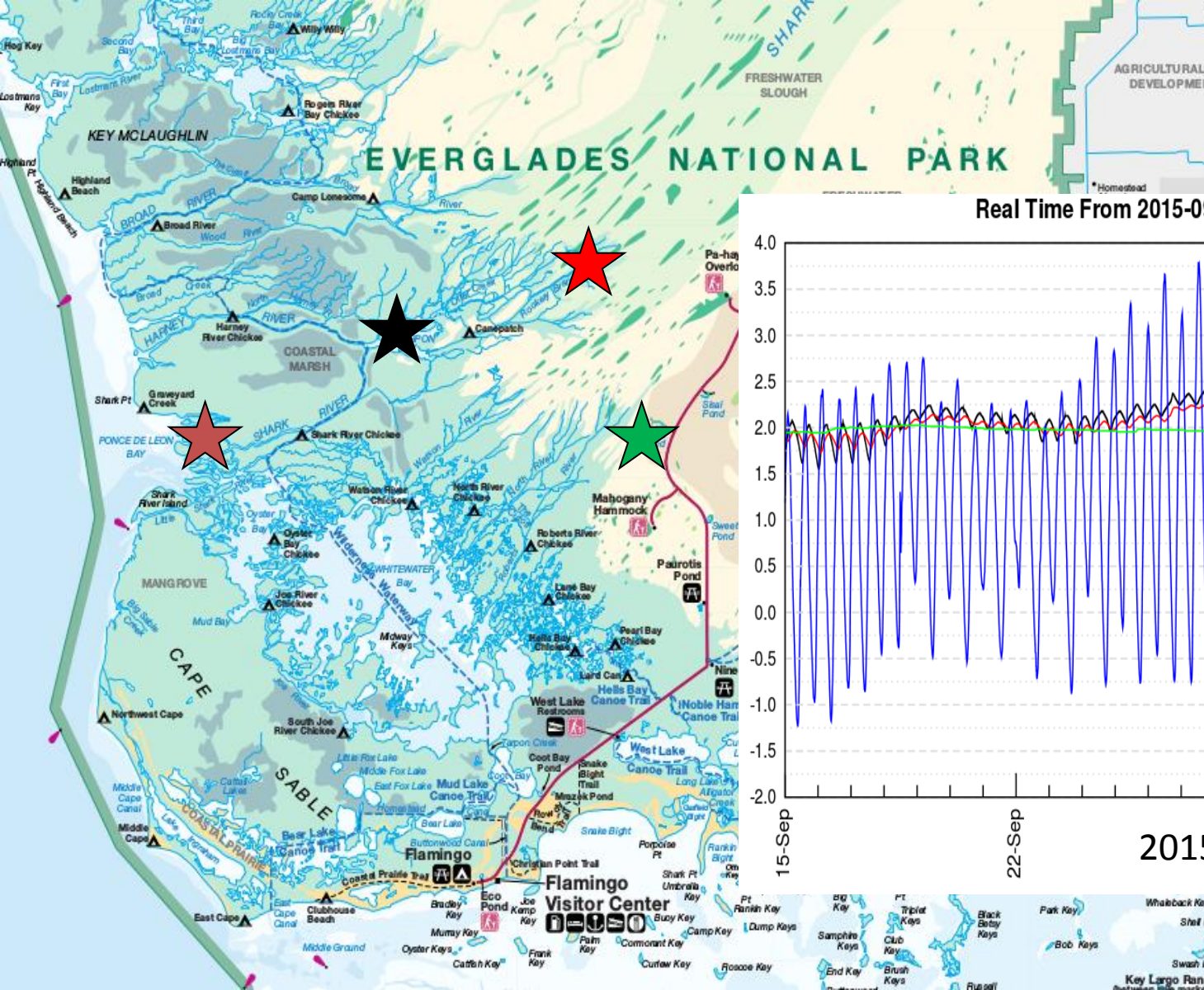
Flooding



**South Creek Village, Key Largo FL
September 30, 2015**

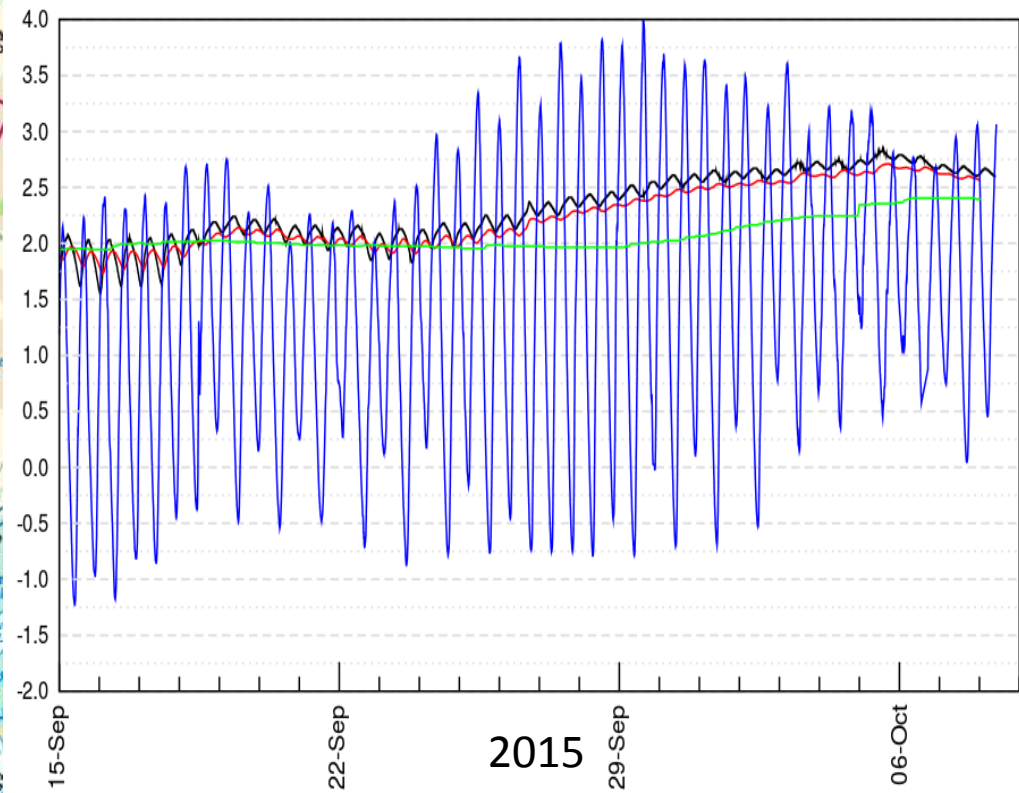


Miami Beach



Water Levels

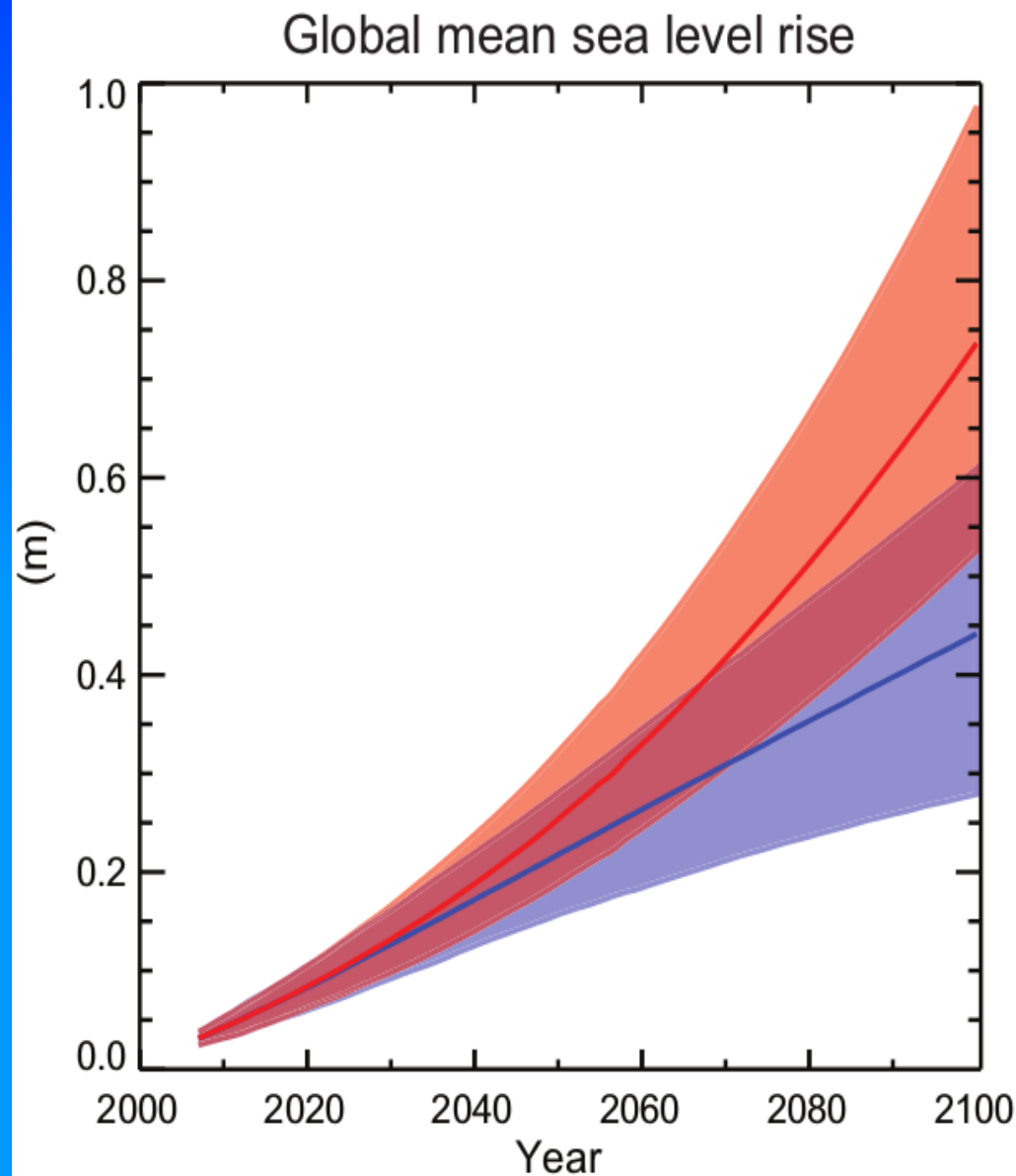
Real Time From 2015-09-15 To 2015-10-08



IPCC

Fifth Assessment Report (AR5)

- 1) Does not include a potential collapse of Antarctic Ice Sheets
- 2) Not Local
- 3) Specific probabilities not provided
- 4) Includes Fantasy Scenario RCP 2.6

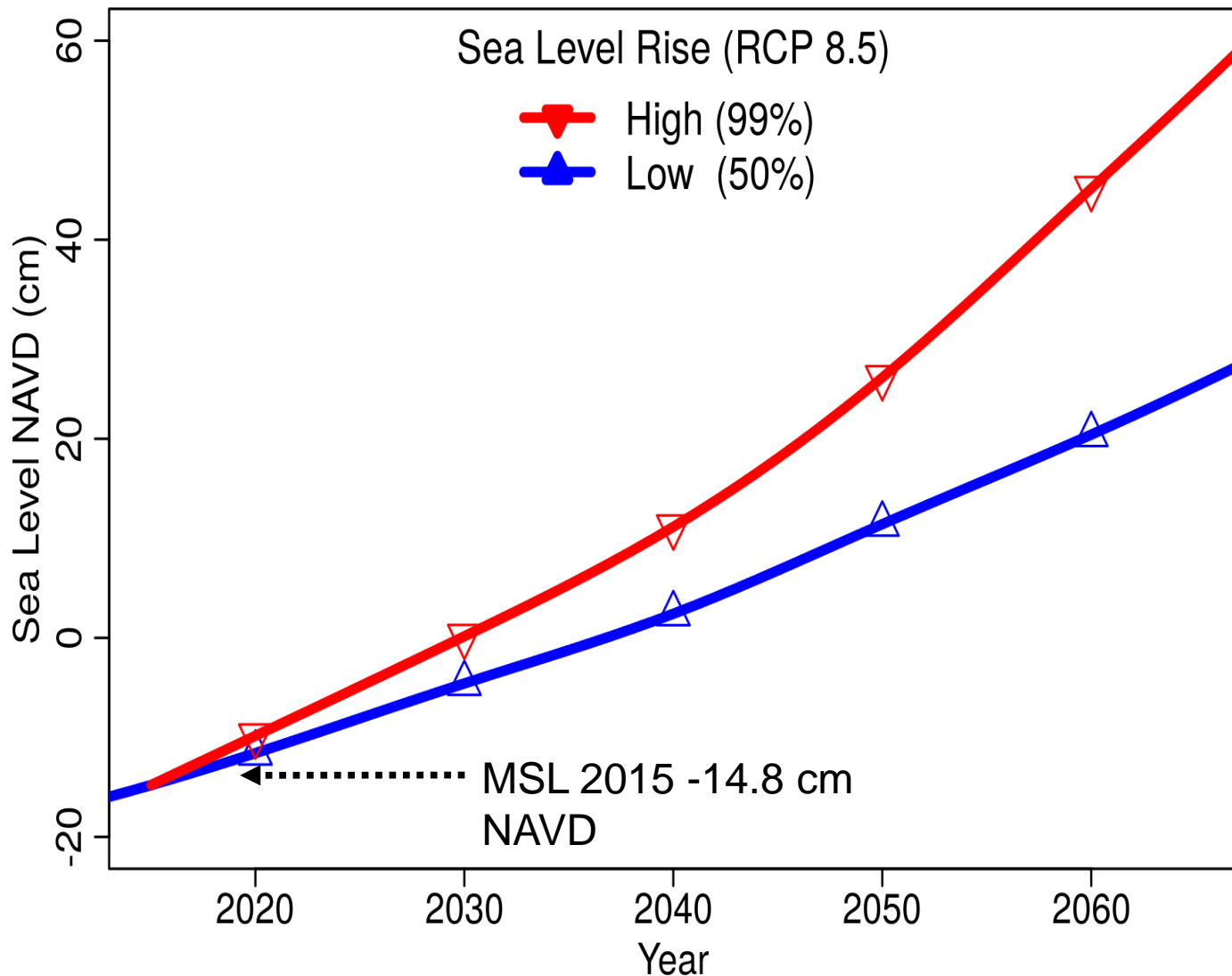


South Florida Sea Level Rise Projection

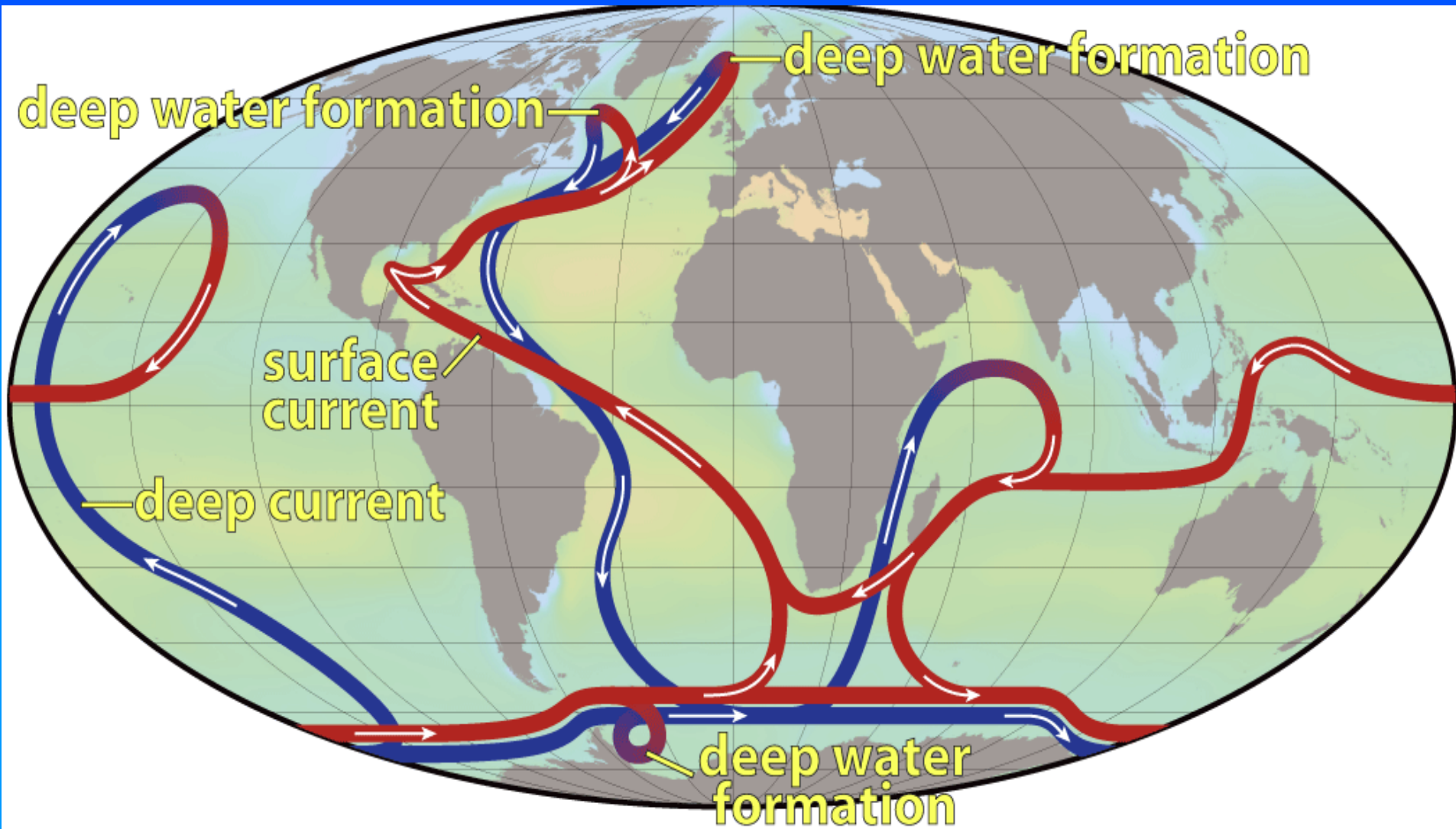
Conservative approach
requires use of median to
high range estimates of
SLR scenario

Reference data:

- Vaca Key, Kopp et al. (2014)
- Florida Bay, 3 gauge average from EVER network



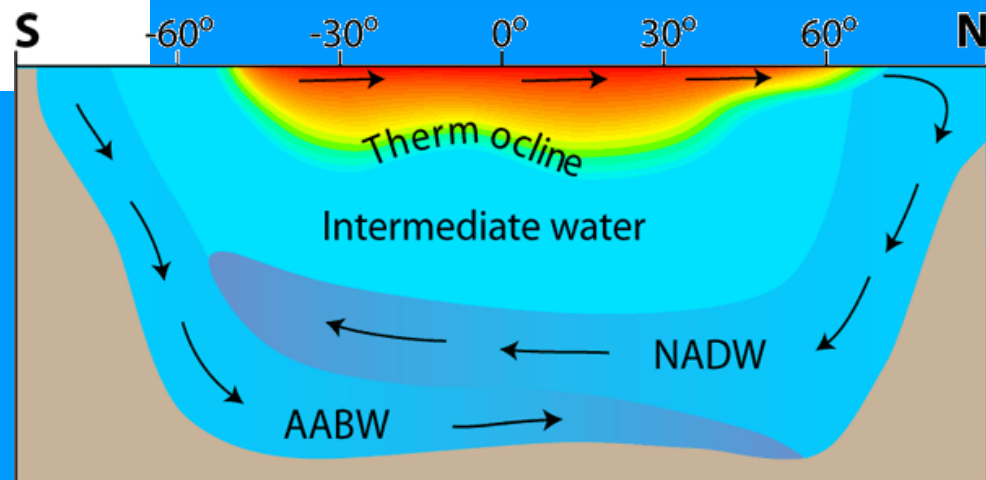
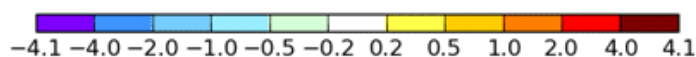
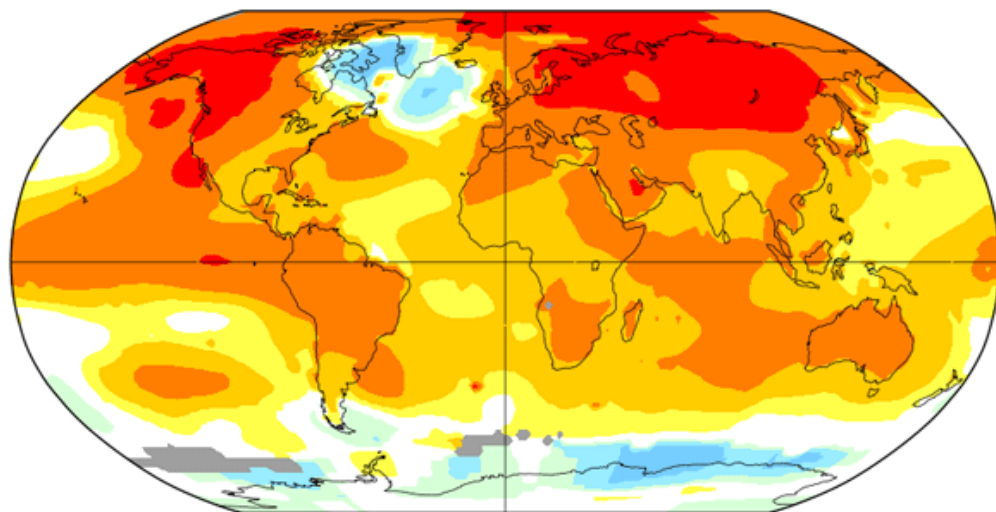
Thermohaline and Boundary Current : AMOC : Gulfstream : Florida Current



Annual J-D 2015

L-OTI(°C) Anomaly vs 1951-1980

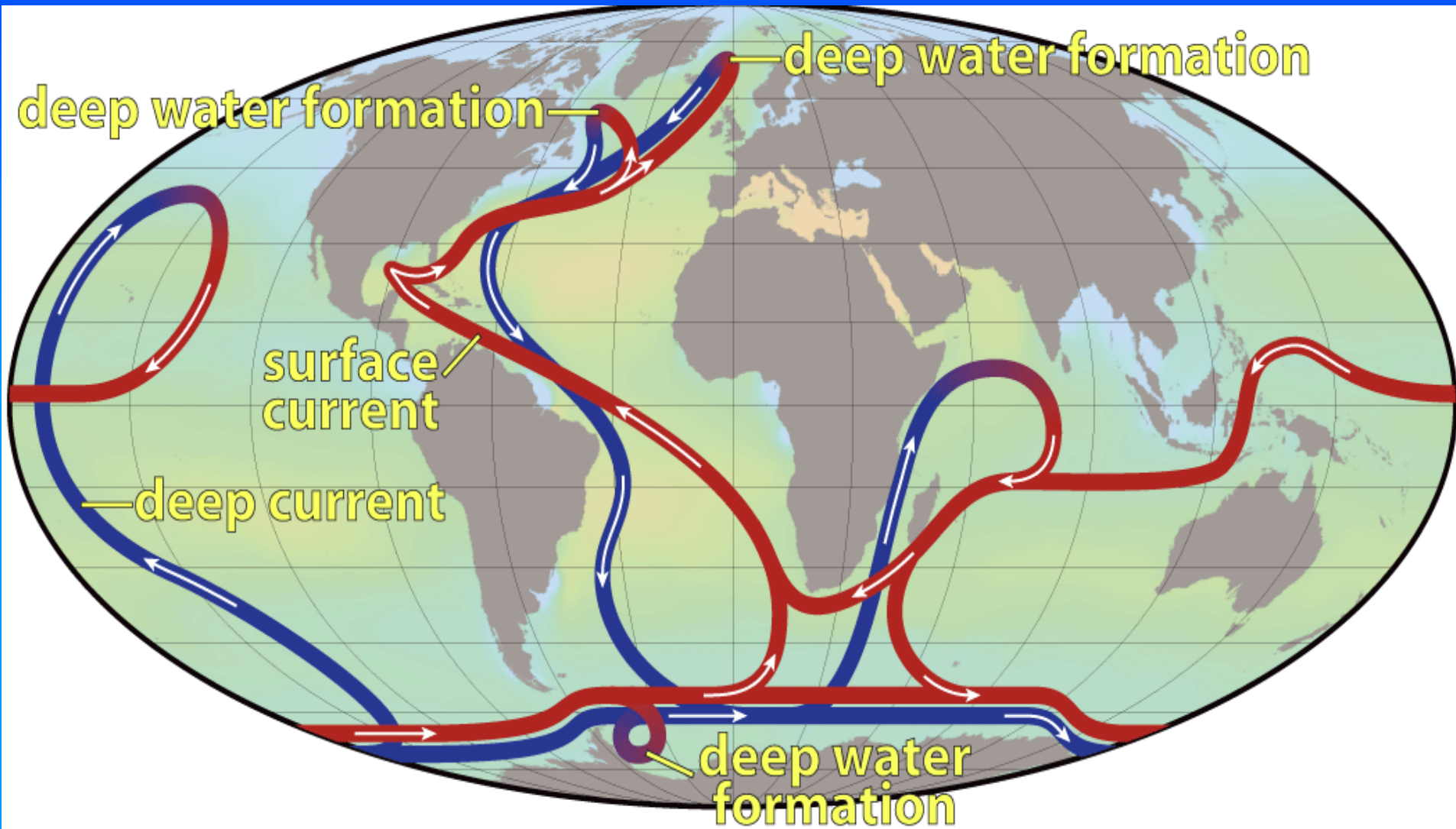
0.85



Increasing CO₂ & nutrients, decreasing O₂

Warm, low nutrient water

Thermohaline and Boundary Current : AMOC : Gulfstream : Florida Current

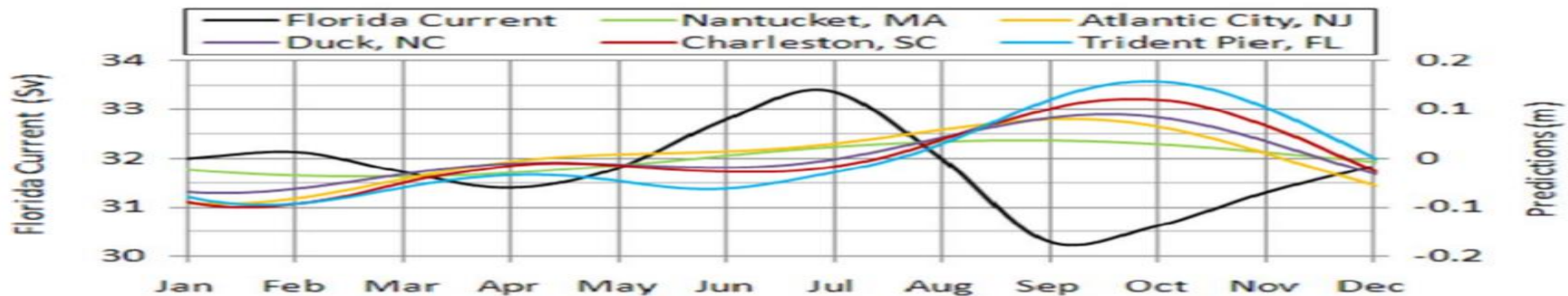
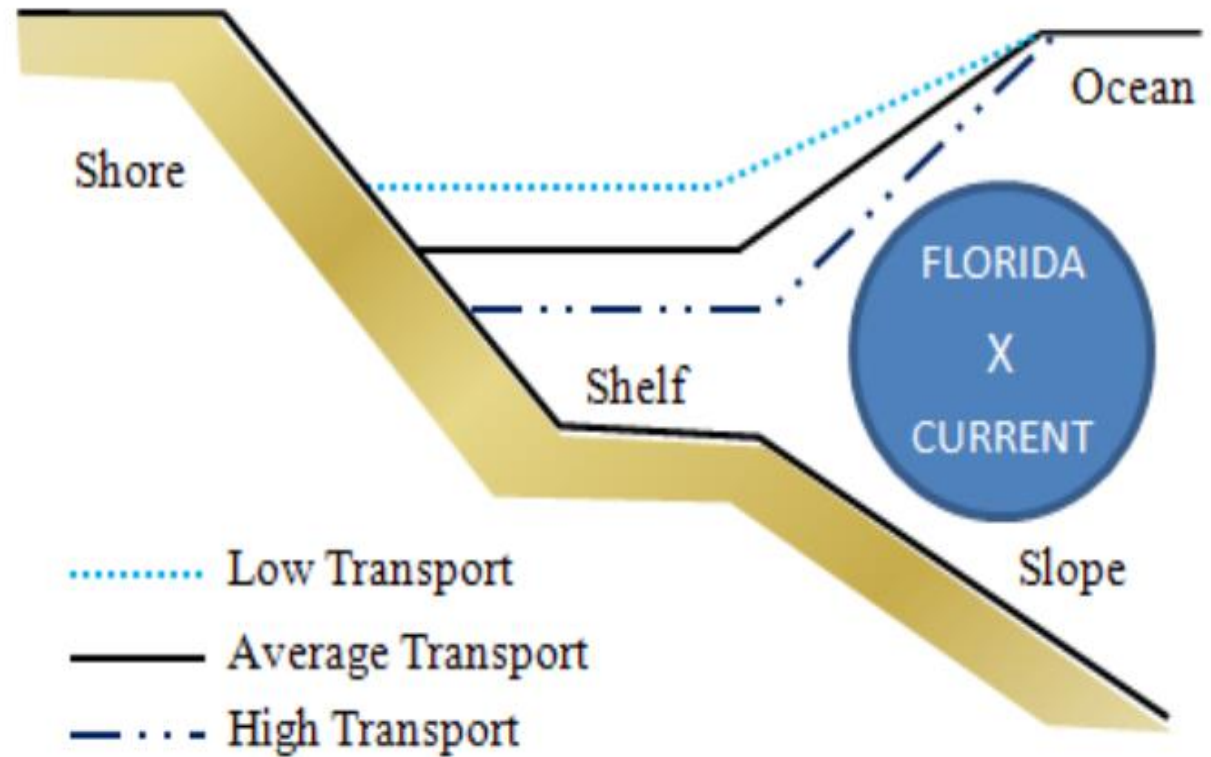




Daniel
Bernoulli

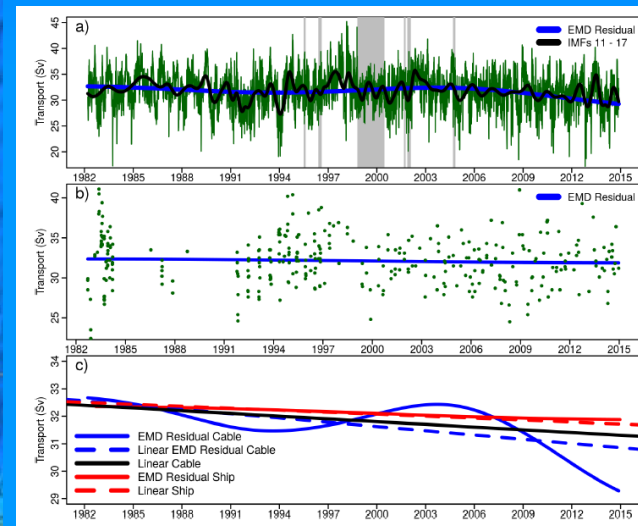
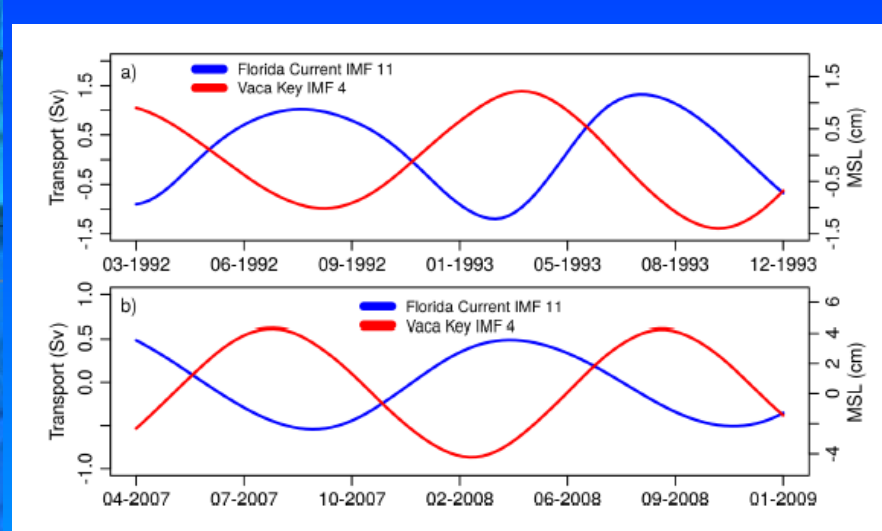
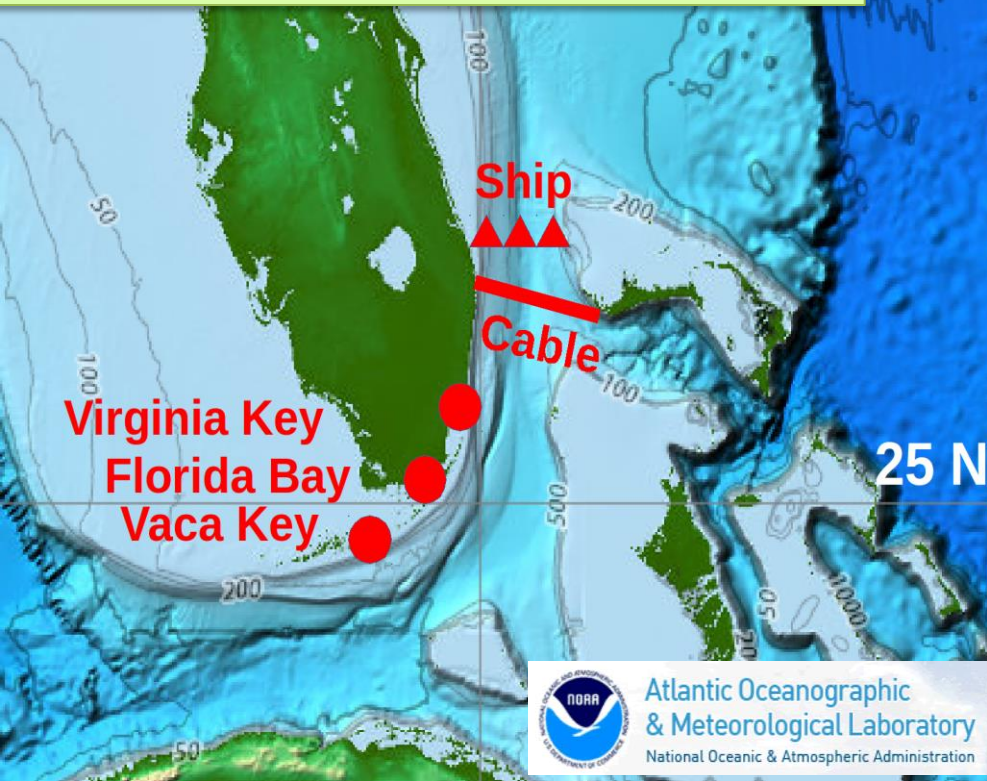
1700 - 1782

$$\frac{v^2}{2} + g Y_0 + \frac{p}{\rho} = C$$



~60% of recent SLR in South Florida is coherent with FC decline: **Twice linear rate.**

30% FC decline ~ 15 cm MSL rise.



Accelerated sea level rise and
Florida Current transport,
Ocean Science, 11, 607-615, 2015



Atlantic Oceanographic
& Meteorological Laboratory
National Oceanic & Atmospheric Administration

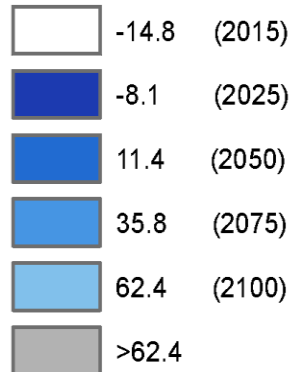
Low (50th Percentile)

ENP

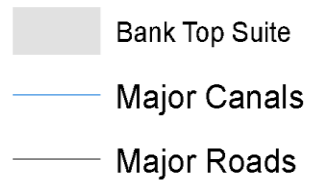
BNP

Elevation NAVD88

cm



Bottom Types



2100
2075
2050
2025
2015

High (99th Percentile)

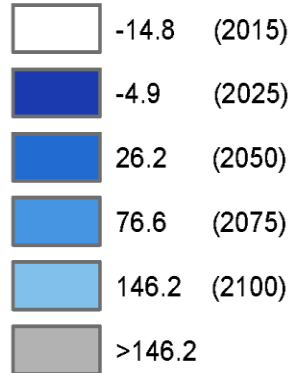
2100

ENP

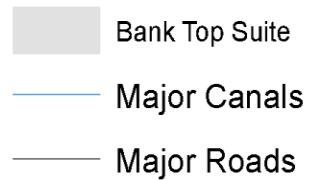
BNP

Elevation NAVD88

cm

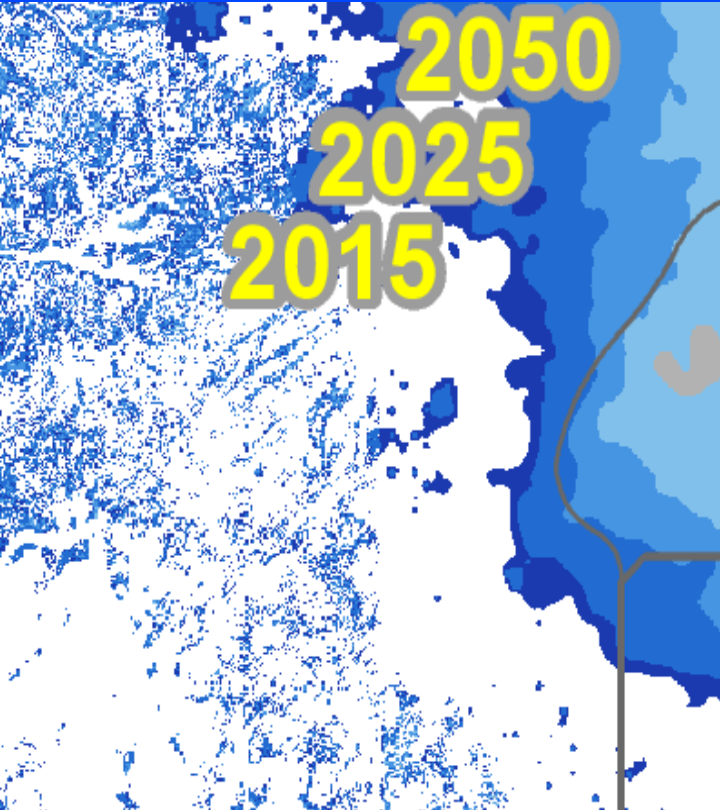


Bottom Types



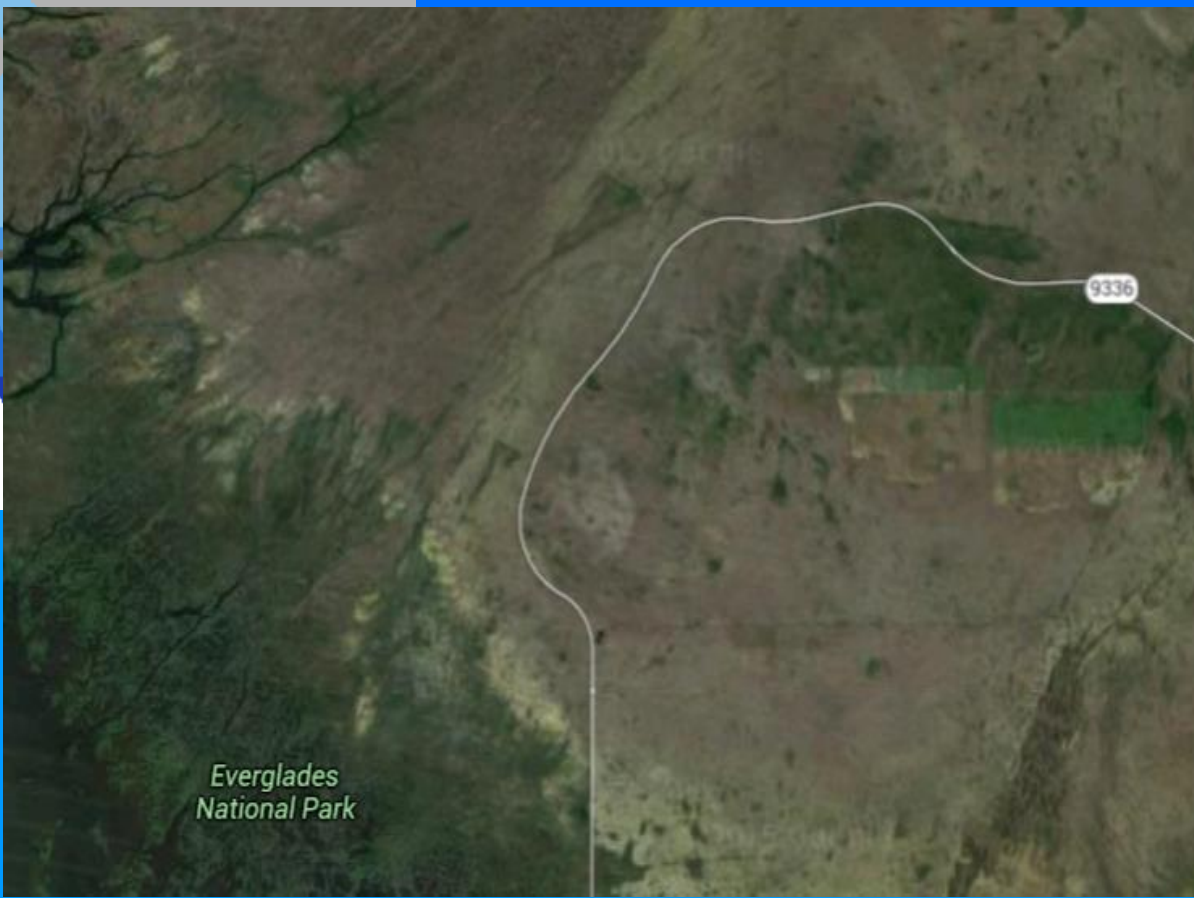


Where is
the
shoreline?



In Everglades: Sea
Level elevation...

*... is not the
shoreline*

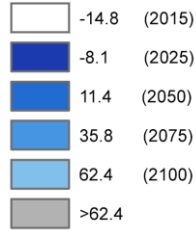


Dry Tortugas

Loggerhead
Key
Lighthouse

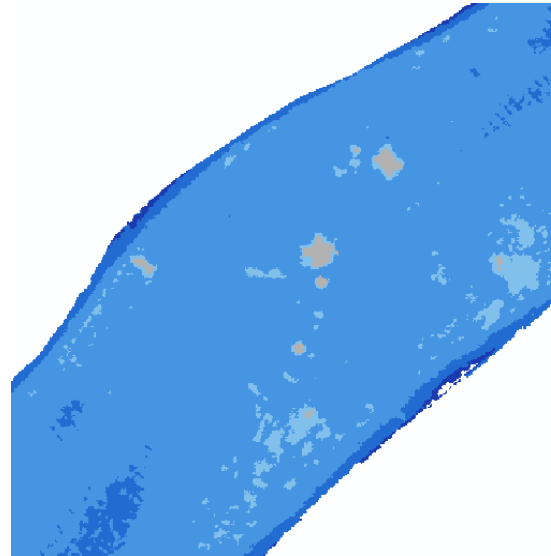
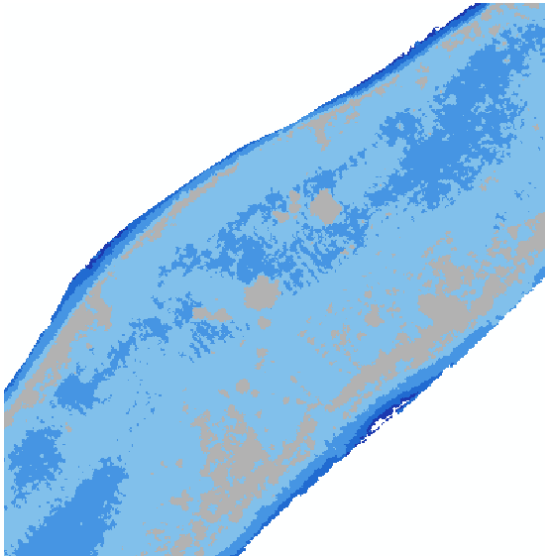
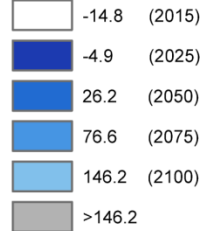
Elevation NAVD88

cm



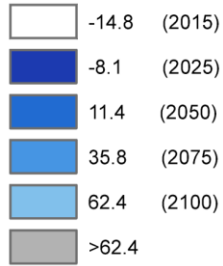
Elevation NAVD88

cm

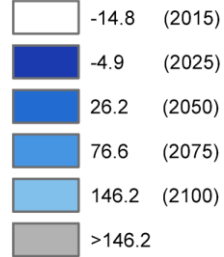


Elevation NAVD88 Elevation NAVD88

cm

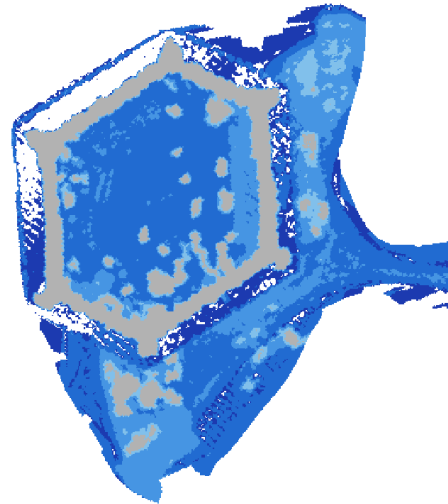
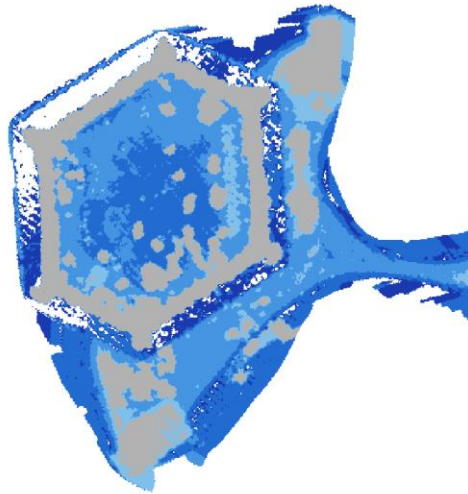


cm



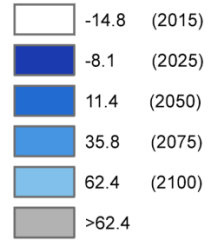
Dry Tortugas

Fort
Jefferson,
Garden Key



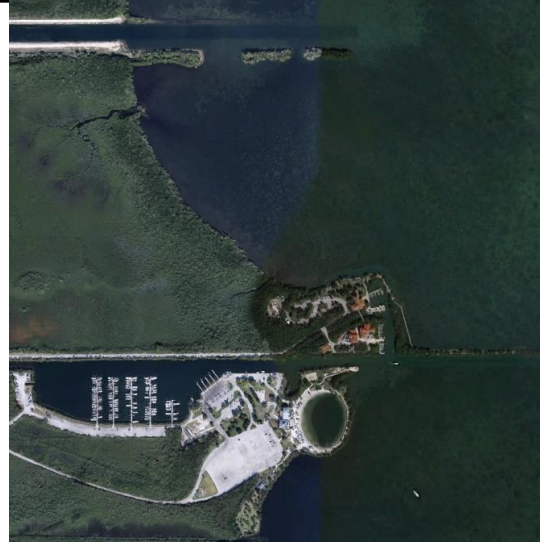
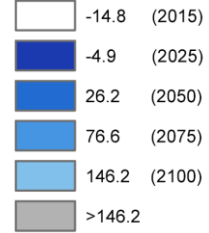
Elevation NAVD88

cm

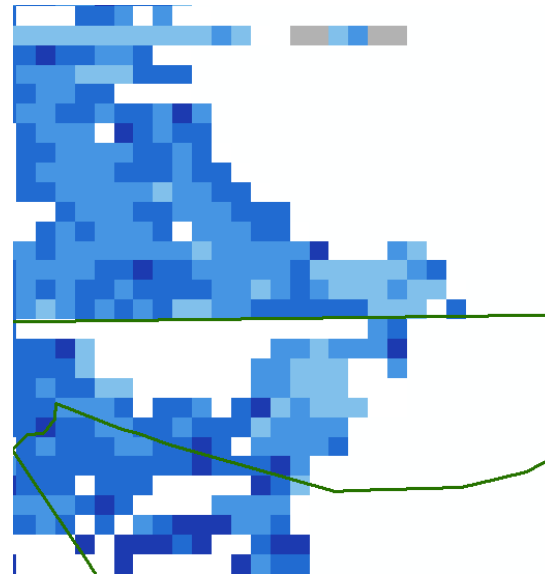
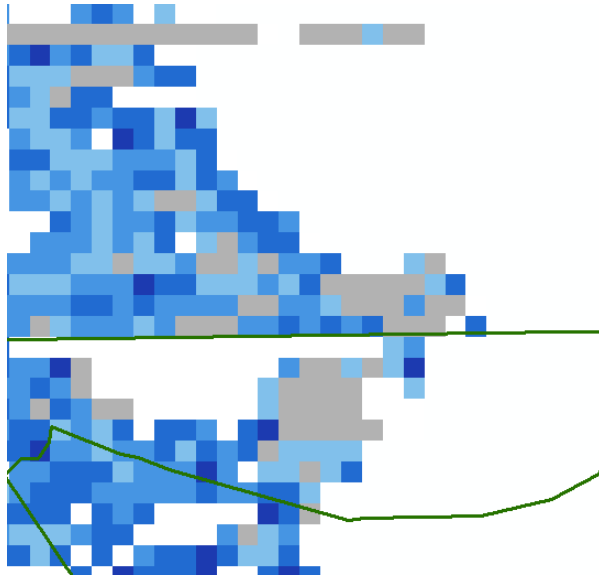


Elevation NAVD88

cm



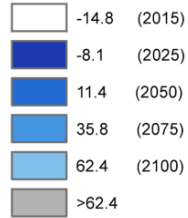
Biscayne National Park visitor center



Biscayne National Park Boca Chita Key

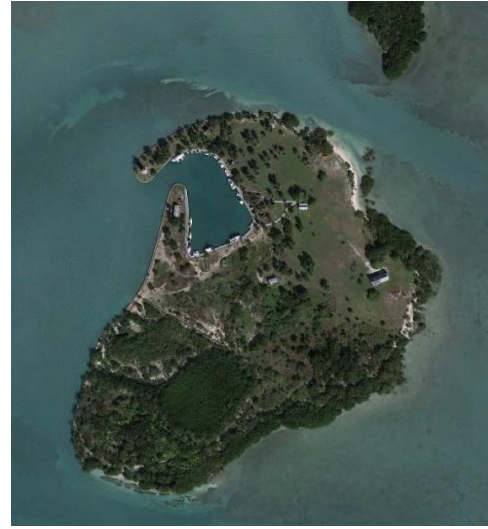
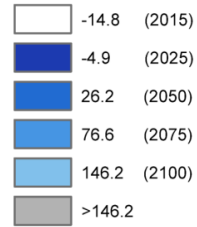
Elevation NAVD88

cm



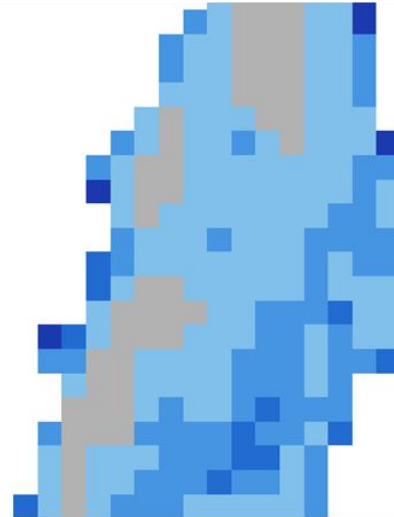
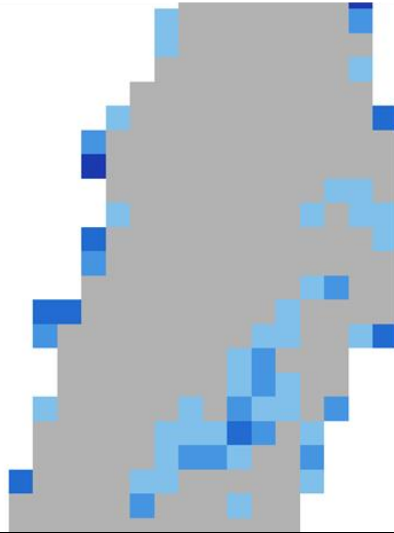
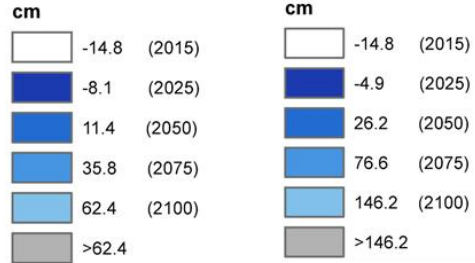
Elevation NAVD88

cm



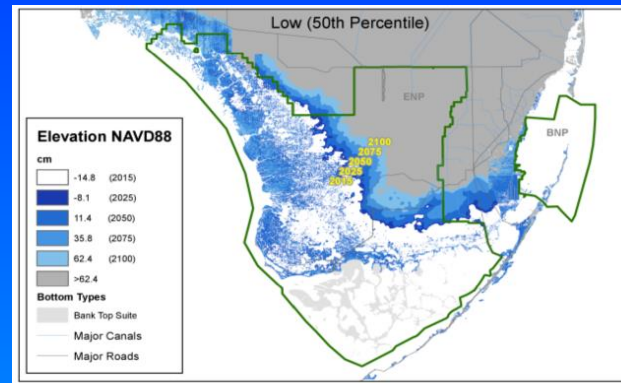
Biscayne National Park Elliot Key

Elevation NAVD88 Elevation NAVD88



Discussion

- Anticipate increased frequency and intensity of nuisance flooding events
- Ice melt rates aren't well known yet
- Other climate factors involved: rain, evapotranspiration, species migration, disease incidents, etc.
- NPS should take highly protective stance



Sea Level Rise Projections for South Florida GIS on the Web

<http://nps.maps.arcgis.com/home/webmap/viewer.html?layers=b61db3e154104ea486528c031390066c>